

## COMPARATIVE PATHOLOGY OF ANNUAL OIL AND FIBRE CROPS.

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Summary

The Pathological Index (PI) is introduced as a measure of the total economic impact caused by diseases in a crop species. PI is calculated according to formula:

$$PI = \frac{\text{N}^\circ \text{ of publications in Rev. Pl. Pathol.}}{\text{N}^\circ \text{ of publications in Pl. Breed. Abs.}} \times 100$$

On the basis of the data obtained from the analysis of a series of annual crops it has been demonstrated that agronomic characters, such as cropping intensity, climatic zone, propagation type (generative or vegetative) and plant part harvested have a great influence on the PI values. Oil and fibre crops as a whole are intermediate with respect to their average PI (35.1) as compared with cereals (26.1) and tuber crops (57.2). Within the group, peanut (72.0), sesamum (52.3) and sunnhemp (50.0) are most affected by diseases; the lowest values were found with hemp (6.2) and castor (13.0). Flax (29.7), poppy (29.8), cotton (30.5), soybean (32.1), rape (32.3), kenaf (33.8), sunflower (34.4), jute (35.6) and safflower (39.3) take an intermediate position. The oil and fibre crops suffer little from bacteria (except sesamum, soybean and cotton) and from viruses and virus-like pathogens (except leguminosae, safflower and sesamum). The most important fungal diseases are associated with damping-off, wilting and infections of roots, stems, fruits and seeds. Fungal leaf-spots play an important part in peanut, sesamum, sunnhemp, kenaf, rape and safflower, rust in peanut, flax, safflower and sunflower, and downy mildew in sunflower and poppy.

Resumen

## PATOLOGIA COMPARATIVA DE OLEAGINOSOS Y TEXTILES ANUALES.

Se introduce el Índice Patológico (IP) como medida del impacto total causado por enfermedades en un cultivo. El IP se calcula de acuerdo a la siguiente fórmula:

$$IP = \frac{\text{N}^\circ \text{ de publicaciones en Rev. Pl. Pathol.}}{\text{N}^\circ \text{ de publicaciones en Pl. Breed. Abs.}} \times 100$$

El análisis de los IPs de una serie de cultivos anuales demuestra que caracteres agronómicos, tales como intensidad de cultivo, zona climática, forma de propagación (generativo o vegetativo) y tipo de órgano cosechado, determinan el comportamiento de las especies frente a enfermedades. El grupo de los oleaginosos y textiles tiene un IP promedio de 35,1 y ocupa un lugar intermedio entre cereales (26,1) y tubérculos (57,2). Dentro del grupo analizado, los IPs más elevados se encuentran en maní (72,0), sésamo (52,3) y crotalaria (50,0) y los más bajo en cáñamo (6,2) y ricino (13,0). Las otras especies ocupan lugares intermedios: lino (29,7), amapola (29,8), algodón (30,5), soja (32,1), colza (32,3), kenaf (33,8), girasol (34,4), yute (35,6) y cártamo (39,3). Los oleaginosos y textiles se ven poco afectados por bacterias (excepto sésamo, soja y algodón) y virus (excepto las leguminosas, cártamo y sésamo).

samo). Las enfermedades más importantes de origen fúngico son aquellas relacionadas con marchitamientos e infecciones en plantines, raíces, tallos, frutos y semillas. Enfermedades foliares causadas por hongos juegan un papel importante en maní, sésamo, crotalaria, kenaf, colza y cártamo, royas en maní, lino, cártamo y girasol, y mildius en girasol y amapola.

### Procedure

It is well known that the impact of disease varies considerably from one crop species to another. However, it is difficult to assess these differences quantitatively. Recently an indirect measure the Pathological Index (PI) has been proposed (Delhey, 1982, 1983), which is calculated according to the following formula:

$$PI = \frac{\text{N}^\circ \text{ of publications in Rev. Pl. Pathol.}}{\text{N}^\circ \text{ of publications in Pl. Breed. Abs.}} \times 100$$

This formula is based on the number of phytopathological publications on each species, as reviewed in the Review of Plant Pathology (RPP). In order to eliminate influencing factors which are not directly related to the disease disposition of a crop (viz. acreage), the figures are divided by the number of publications on the same species, reviewed in Plant Breeding Abstracts (PBA).

Partial PI values can also be determined by taking into consideration only the number of publications dedicated to certain disease types (virus diseases, bacterial diseases, rusts, etc.). This permits the establishment of a pathological profile for each crop species.

A first analysis of a crop group has been attempted for tuber crops (Delhey, 1983). In the present paper, 14 annual oil and fibre crops are submitted to a similar analysis. In the case of rape, peanut, soybean, flax, cotton, and sunflower, a five-year period (1976-80) of RPP and PBA has been evaluated, whereas for the other species (hemp, poppy, sunnhemp, castor, jute, kenaf, sesamum, safflower) this period was extended to twelve years (1969-80) in order to amplify the numerical basis for the calculations.

### Results and discussion

The diseases: Virus and virus-like agents, bacteria and fungi are the pathogens considered in the study. The latter are subdivided into six groups: those causing foot diseases and related problems, foliar diseases, white rusts, downy mildews, powdery mildews, and rusts.

Virus and virus-like diseases: This group includes diseases caused by viruses, viroids, mycoplasma-like organisms (MLO) and rickettsia-like organisms (RLO). The latter two are in fact procaryotes but they have been included here for two reasons: firstly, they have long been confused with viruses; and secondly, the diseases produced in many respects resemble those caused by viruses rather than by the "normal" plant pathogenic bacteria, especially in their symptomatology, their relation to the host tissue (obligate parasitism, intracellular localization, systemic infection, restriction to phloem and xylem) and their epidemiology (dependence on insect vectors, graft transmissibility).

Viruses and related pathogens may cause very diverse symptoms, but their most striking effect is on the primary productivity of the plants via reduction of

the leaf area and damage to the chloroplasts. The most affected species are the three leguminosae included here (sunhemp, peanut and soybean) and sesamum. Viruses are of little significance in flax, castor, kenaf, sunflower, and cotton. Oil and fibre crops as a whole suffer little from viruses in contrast to tuber crops and vegetables (Delhey, 1983).

Most viruses and virus-like disease agents depend on vectors for their dissemination. Aphids are the most important group of vectors in oil and fibre crops (56%), especially in soybean, peanut and rape. The other vector groups include leafhoppers and planthoppers (11%), white flies (9%), beetles (8%), and nematodes (7%). A comparative analysis in cereals (Delhey, unpublished) has shown that leafhopper and planthopper-transmitted viruses (53%) are more important than aphid-transmitted ones (27%).

Bacterial diseases: Bacteria may cause a number of quite diverse disease types, including cankers, soft rots, wilting and others. The species which attack oil and fibre crops most frequently produce blights and leaf-spots. The most affected crops include sesamum, soybean, cotton, poppy and jute. Most of these bacteria are seed-borne.

Foot diseases: This is a very heterogeneous group, which comprises fungal diseases such as damping-off, seedling blight, root and stem rots, wilting, lodging and so on. As in many cases the same pathogens also produce infections on inflorescences, fruits and seeds, diseases of these organs are also included here. Genera which are frequently associated with foot diseases are Phytophthora, Fusarium, Verticillium, Sclerotinia, Macrophomina, Sclerotium, Rhizoctonia and others. Aspergillus, Botrytis, Rhizopus etc. are important pathogens of the reproductive plant parts. Most of these pathogens live in the soil, surviving as saprophytes or in the form of sclerotia or resting spores. In addition to soil transmission, seed transmission also occurs in many cases.

In all the oil and fibre crops analyzed here, the foot disease group is by far the most important, causing death or weakening of plants and deterioration of the harvested products. The relative importance of such diseases is highest in tropical and subtropical species (peanut, jute, kenaf, cotton, safflower, and sesamum).

Foliar diseases: The fungi causing leaf-spots, shot-holes, blights, anthracnose and related symptoms mainly affect the primary productivity of their host plants by reducing the photosynthetically active leaf area. They belong to genera such as Septoria, Cercospora, Alternaria, etc. Foliar diseases are important in all the crops studied here, but especially severe in peanut, sesamum, kenaf, and rape.

White rusts: This disease, caused by Albugo spp., is restricted to temperate zones, having some significance in rape and, to a much lesser extent, in sunflower.

Downy mildews: Most representatives of the Peronosporaceae family, which cause downy mildews, are found in cooler regions. Sunflower is severely affected by Plasmopara halstedii and poppy by Peronospora arborescens. Other species cause problems in soybean and rape.

Powdery mildews: These are produced by members of the Erysiphales and are typical in relatively dry regions in the temperate and subtropical zones. Only in sesamum and poppy have they been found to be of significance.

Rusts: Some of the crops studied here suffer considerably from rusts, caused by Uredinales. The most affected species are peanut, flax, safflower, sunflower, and soybean.

The crops: Although the oil and fibre crops studied here are a very heterogeneous group with respect to their taxonomic position (the 14 species belong to 10 plant families), their PI values are rather uniform, with the exception of hemp and castor, with very low, and sunnhemp, sesamum and peanut, with high PI values.

Hemp (Cannabis sativa): This species has a surprisingly low PI (6.2) which should be interpreted with caution as the number of papers reviewed in RPP from 1969 to 1980 is only 18. Foot diseases, leaf-spots and bacterial diseases seem to be the outstanding problems.

Poppy (Papaver spp.): The PI value is 29.8, foot diseases being by far the most important, accounting for 55 per cent of the total. Downy mildew, bacterial and virus diseases, and powdery mildew are also important. The most mentioned pathogens are Pleospora papaveracea and Peronospora arborescens.

Rape (Brassica napus, including also B. campestris, B. carinata and B. juncea): Foot diseases account for 57 per cent of the PI value of 32.3, and foliar diseases for another 21 per cent. White rusts and viruses also have some significance. Leptosphaeria maculans, Plasmodiophora brassicae, Alternaria brassicae, Sclerotinia sclerotiorum and Albugo candida are the most named pathogens.

Peanut (Arachis hypogaea): This crop has the highest PI value (72.0), 43 per cent of which is due to foot diseases (including fruit and seed infections). Viruses, leaf-spots and rust are also of considerable significance in this crop. Bacteria are practically absent. The most mentioned pathogens are Puccinia arachidis, Sclerotium rolfsii, Aspergillus flavus, Mycosphaerella arachidis, M. berkeleyi, Cylindrocladium crotalariae and groundnut rosette virus.

It is tempting to speculate on how far the high disease incidence, including the aflatoxin problem, might be responsible for the fall behind of peanut in comparison to other oil crops.

Soybean (Glycine max): This species has a PI of 32.1, of which 34 per cent is due to foot diseases and 26 per cent to viruses. Important problems are also caused by bacteria, leaf-spot and rust fungi and, to a lesser extent, by downy and powdery mildews. The list of the most mentioned pathogens is headed by soybean mosaic virus, followed by Phytophthora megasperma, Phakopsora pachyrrhizi, Xanthomonas campestris pv. phaseoli, Peronospora manshurica, Pseudomonas syringae pv. glycinea and Rhizoctonia solani.

Sunnhemp (Crotalaria juncea): This fibre crop has a relatively high PI of 50.0 but the numerical basis for this determination is very small. Foot and virus diseases are the most important problems.

Flax (Linum usitatissimum): Of the PI value of 29.7, 52 per cent is due to foot diseases, 27 per cent to rust and 15 per cent to foliar diseases. Fusarium oxysporum f. sp. lini, Melampsora lini, Mycosphaerella linorum and Colletotrichum linicola are the dominant pathogens.

Castor (Ricinus communis): The PI value is relatively low (13.0), and 55 per cent of the problems are caused by foot diseases. Leaf-spots also are important.

Jute (Corchorus capsularis, C. olitorius): Of the PI value of 35.6 no less than 73 per cent is due to foot problems. Foliar, bacterial and virus diseases are of minor importance. Macrophomina phaseolina is by far the most named pathogen, followed by Colletotrichum corchori.

Cotton (Gossypium spp.): The PI value is 30.5, being 77 per cent of the disease problems due to foot infections. Bacteria and leaf-spots are also important. The most mentioned pathogen is Verticillium dahliae, followed by Fusarium oxysporum f. sp. vasinfectum, Xanthomonas campestris pv. malvacearum and Rhizoctonia solani.

Kenaf (Hibiscus cannabinus, including also roselle, H. sabdariffa): The PI of 33.8 is almost exclusively due to foot diseases (72%) and leaf-spots (25%). Phytophthora nicotianae var. parasitica, Rhizoctonia solani and Collectotrichum hibisci are the dominant pathogens.

Sesamum (Sesamum indicum): This species has a high PI value (52.3), foot, bacterial and foliar diseases accounting for 39, 21 and 20 per cent, respectively. Viruses and powdery mildews are also present. The most mentioned pathogens are Macrophomina phaseolina, Xanthomonas campestris pv. sesami, sesame phyllody MLO, Phytophthora nicotianae var. parasitica, Pseudomonas sesami and Fusarium oxysporum f. sp. sesami.

Safflower (Carthamus tinctorius): The PI value of 39.3 is mainly due to foot diseases (56%). Rusts, leaf-spots and virus-like diseases are also important. There are three predominant pathogens: Phytophthora drechsleri, Puccinia carthami and Fusarium oxysporum f. sp. carthami.

Sunflower (Helianthus annuus): This species has an intermediate PI of 34.4, of which 35 per cent is due to foot diseases, 28 per cent to downy mildew, 15 per cent to rust and 14 per cent to foliar diseases. Plasmopara halstedii, Puccinia helianthi, Sclerotinia sclerotiorum and Alternaria helianthi are the most named pathogens.

The average PI value of the whole group of oil and fibre crops is 35.1, taking thus an intermediate position between cereals (26.1) and tuber crops (57.2) (Delhey, unpublished). In earlier publications (Delhey, 1982, 1983) it has been demonstrated that there is a correlation between high PI values and vegetatively rather than generatively propagated crops, high intensity rather than low intensity crops, and low latitude rather than high latitude crops. In addition, species grown for their dry seeds suffer less from diseases than those where subterranean products (tubers, roots, bulbs), stems or leaves, or soft fruits are the harvested products.

The annual oil and fibre crops analyzed here are all seed-propagated, are grown at low to intermediate levels of cropping intensity, and with a few exceptions, dry seeds are the plant parts harvested. These agronomic characteristics undoubtedly contribute to the relatively low PI values of these crops compared to tuber crops, vegetables, tobacco, etc.

As already pointed out, the major disease problems affecting oil and fibre crops is caused by "foot diseases" and related problems which result in plant loss and seed deterioration. The fungi responsible for these diseases are soil-borne. Transmission by seed occurs in the case of many bacteria, fungi which cause foot infections, foliar diseases and downy mildews, as well as with some viruses.

In order to reduce the disease pressure on these crops control measures should be aimed at influencing the survival rate of pathogens in the soil and minimizing seed transmission by the production of "clean" seed and physical and chemical seed treatments.

#### References

DELHEY, R. 1982. Índice Patológico y Perfil Patológico en cultivos anuales. Actas del 2º Congreso Latinoamericano de Fitopatología. Buenos Aires, 22-26 de noviembre, 1982 (in press).

DELHEY, R. 1983. The disease disposition of tuber crops as compared to other annual crops. Proceedings of the 6th Symposium of the International Society for Tropical Root Crops. Lima, 20-25 February, 1983 (in press).

Plant Breeding Abstracts 39 (1969) to 50 (1980)

Review of Applied Mycology 48 (1969)

Review of Plant Pathology 49 (1970) to 59 (1980)